The Future of Wireless and First Responders

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Wireless Technology and First Responder

- Wireless Past and Present
- Wireless Future
- First Responders and Wireless
Subscriber Growth

Number of Subscribers

Source: CTIA
Cellular Statistics

Cellular Users
~250 Million
~81% Penetration

Average Life of a Cell Phone: 14-18 Months

First Responders in US
~2.5 Million

Source: CTIA, WiFi Alliance
2007 Financial Comparison

Annual Revenues of Cellular Industry
$154 Billion

Capital Investment
$23.6 Billion

Public WiFi Annual Revenue
$3B

DHS 2007 program budget
$35.6 Billion

DHS Grants for Interoperability
$1B

Source: CTIA, Homeland Defense Journal, WiFi Alliance
CDMA Cellular Coverage

Map Legend
- Digital Coverage
- Analog Coverage
- No Coverage

Map Legend
- Broadband
- Enhanced Services
- Extended Enhanced Services
- No Coverage

Source: Verizon Wireless
GSM and 3G Coverage

Source: GSM Association
WiFi Coverage

Source: Frost & Sullivan
Data Rates Evolution

Speed bps

10Gbps
1Gbps
100Mbps
10Mbps
1Mbps
100k
10k

Years
1985
1990
1995
2000
2005
2010

Technologies:
- WiFi
- IS-95A
- IS-95B
- GSM
- GPRS
- EDGE
- 1xEVDO
- 1xEVDO A
- CDMA 1x
- P25
- TETRA
- HSPA
- UMTS
- LTE

INL Idaho National Laboratory
Handset Sales

Global Handset Sales by Technology (1)

<table>
<thead>
<tr>
<th>Year</th>
<th>Other (3)</th>
<th>CDMA One, CDMA2000 1x, 1xEV</th>
<th>WCDMA</th>
<th>GSM, GPRS, EDGE</th>
<th>Total Handsets</th>
</tr>
</thead>
<tbody>
<tr>
<td>2002</td>
<td>86</td>
<td>76</td>
<td>0</td>
<td>273</td>
<td>435</td>
</tr>
<tr>
<td>2003</td>
<td>84</td>
<td>102</td>
<td>3</td>
<td>341</td>
<td>530</td>
</tr>
<tr>
<td>2004</td>
<td>57</td>
<td>132</td>
<td>17</td>
<td>475</td>
<td>681</td>
</tr>
<tr>
<td>2005</td>
<td>32</td>
<td>153</td>
<td>44</td>
<td>594</td>
<td>823</td>
</tr>
<tr>
<td>2006</td>
<td>21</td>
<td>177</td>
<td>79</td>
<td>668</td>
<td>945</td>
</tr>
</tbody>
</table>

Source: Strategy Analytics, Inc. - January 2006
# Major US Operators (October 2007)

<table>
<thead>
<tr>
<th>Operator</th>
<th>Technology</th>
<th>Subscribers (millions)</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT&amp;T</td>
<td>HSDPA, UMTS, EDGE, GPRS, GSM, TDMA</td>
<td>65.7</td>
</tr>
<tr>
<td>Verizon Wireless</td>
<td>CDMA2000 1xEV-DO, CDMA2000 1x, CDMA</td>
<td>63.7</td>
</tr>
<tr>
<td>Sprint Nextel</td>
<td>CDMA2000 1xEV-DO, CDMA2000 1x, CDMA (Sprint PCS), WiDEN, iDEN (Nextel)</td>
<td>54.0</td>
</tr>
<tr>
<td>T-Mobile</td>
<td>UMA, EDGE, GPRS, GSM</td>
<td>26.9</td>
</tr>
<tr>
<td>Alltel</td>
<td>CDMA2000 1xEV-DO, CDMA2000 1x, CDMA, AMPS</td>
<td>12.447</td>
</tr>
<tr>
<td>TracFone</td>
<td>GSM, CDMA, TDMA</td>
<td>8.803</td>
</tr>
<tr>
<td>U.S. Cellular</td>
<td>CDMA2000 1x, CDMA, TDMA</td>
<td>6.010</td>
</tr>
<tr>
<td>Virgin Mobile</td>
<td>CDMA2000 1xEV-DO, CDMA2000 1x, CDMA</td>
<td>5.2</td>
</tr>
<tr>
<td>MetroPCS</td>
<td>CDMA</td>
<td>3.66</td>
</tr>
</tbody>
</table>

Source: Operator Quarterly Reports
Wireless Technology and First Responder

- Wireless Past and Present
- Wireless Future
- First Responders and Wireless
## Operator Migrations

<table>
<thead>
<tr>
<th>Operator</th>
<th>Current Technology</th>
<th>Migrating to:</th>
</tr>
</thead>
<tbody>
<tr>
<td>at&amp;t</td>
<td>TDMA, GSM, GPRS, EDGE, UMTS, HSDPA</td>
<td>LTE</td>
</tr>
<tr>
<td>verizon wireless</td>
<td>IS-95, CDMA2000 1x, CDMA2000 1xEV-DO</td>
<td>LTE</td>
</tr>
<tr>
<td>Sprint</td>
<td>IS-95, CDMA2000 1x, CDMA2000 1xEV-DO</td>
<td>WiMax</td>
</tr>
<tr>
<td>T-Mobile</td>
<td>GSM, GPRS, EDGE, WiFi</td>
<td>LTE ????</td>
</tr>
<tr>
<td>Alltel wireless</td>
<td>IS-95, CDMA2000 1xEV-DO</td>
<td>????</td>
</tr>
</tbody>
</table>

### Current Subscriber Market Share

- **Verizon Wireless**: 25%
- **Sprint Nextel**: 22%
- **T-Mobile USA**: 10%
- **Alltel**: 5%
- **Other**: 13%

Source: Carrier Press Releases
WiMax

Industry research analysts are bullish about prospects of WiMAX especially in Asia-Pacific and Europe.

Derived from reports by:
- Morgan Stanley
- Gartner
- Pyramid Research
- iSuppli
- IDC (chipset viewpoint)
- Maravedis (09.2006)

<table>
<thead>
<tr>
<th>Region</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>North America</td>
<td>0.25</td>
<td>0.69</td>
<td>1.18</td>
<td>1.73</td>
</tr>
<tr>
<td>Europe</td>
<td>0.60</td>
<td>1.89</td>
<td>2.07</td>
<td>3.19</td>
</tr>
<tr>
<td>APAC</td>
<td>0.76</td>
<td>1.72</td>
<td>2.55</td>
<td>3.32</td>
</tr>
<tr>
<td>Latin America</td>
<td>0.16</td>
<td>0.33</td>
<td>0.41</td>
<td>0.52</td>
</tr>
<tr>
<td>Middle East and Africa</td>
<td>0.20</td>
<td>0.47</td>
<td>0.41</td>
<td>0.52</td>
</tr>
<tr>
<td>Average connections (MM)</td>
<td>1.95</td>
<td>4.29</td>
<td>6.62</td>
<td>9.28</td>
</tr>
</tbody>
</table>

Source: Sprint, Clearwire and Analysts

258,000 Subscribers
The image contains a table and a diagram regarding the 700 MHz Auction, detailing the frequencies, bandwidth, pairing, area type, and licenses for various blocks.

### Lower 700 MHz Band
Channels 52-59

<table>
<thead>
<tr>
<th>Block</th>
<th>Frequencies</th>
<th>Bandwidth</th>
<th>Pairing</th>
<th>Area Type</th>
<th>Licenses</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>698-704, 728-734</td>
<td>12 MHz</td>
<td>2 x 6 MHz</td>
<td>EA</td>
<td>176</td>
</tr>
<tr>
<td>B</td>
<td>704-710, 734-740</td>
<td>12 MHz</td>
<td>2 x 6 MHz</td>
<td>CMA</td>
<td>734</td>
</tr>
<tr>
<td>C</td>
<td>710-716, 740-746</td>
<td>12 MHz</td>
<td>2 x 6 MHz</td>
<td>CMA</td>
<td>734*</td>
</tr>
<tr>
<td>D</td>
<td>716-722</td>
<td>6 MHz</td>
<td>unpaired</td>
<td>EAG</td>
<td>6*</td>
</tr>
<tr>
<td>E</td>
<td>722-728</td>
<td>6 MHz</td>
<td>unpaired</td>
<td>EA</td>
<td>176</td>
</tr>
<tr>
<td>C</td>
<td>746-757, 776-787</td>
<td>22 MHz</td>
<td>2 x 11 MHz</td>
<td>REAG</td>
<td>12</td>
</tr>
<tr>
<td>D</td>
<td>758-763, 788-793</td>
<td>10 MHz</td>
<td>2 x 5 MHz</td>
<td>Nationwide</td>
<td>1**</td>
</tr>
</tbody>
</table>

### Upper 700 MHz Band
Channels 60-69

<table>
<thead>
<tr>
<th>Block</th>
<th>Frequencies</th>
<th>Bandwidth</th>
<th>Pairing</th>
<th>Area Type</th>
<th>Licenses</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>757-758, 787-788</td>
<td>2 MHz</td>
<td>2 x 1 MHz</td>
<td>MEA</td>
<td>52***</td>
</tr>
<tr>
<td>B</td>
<td>775-776, 805-806</td>
<td>2 MHz</td>
<td>2 x 1 MHz</td>
<td>MEA</td>
<td>52***</td>
</tr>
</tbody>
</table>

*Blocks have been auctioned.
**Block is associated with the 700 MHz Public/Private Partnership.
***Guard Bands blocks have been auctioned, but are being relocated.

Source: FCC
700 MHz Major players

- C Block
  - Google
  - verizon
  - at&t
  - T-Mobile

- D Block
  - verizon
  - frontline

- What will 700 MHz Technologies be?
  - Likely LTE if cellular providers win
  - If Google Wins, WiMax?

Source: RCR Wireless
Wireless Technology and First Responder

- Wireless Past and Present
- Wireless Future
- First Responders and Wireless
System of Systems

EAN: Extended Area Network
JAN: Jurisdictional Area Network
IAN: Incident Area Network
PAN: Personal Area Network

Source: SAFECOM SoR v1.1
Public Safety Communications Device

- **Interface capability**
  - Qwerty Keyboard, real or virtual
  - Camera
  - Adequate Screen Size
  - Stylus/Touch Screen

- **Wireless Capabilities**
  - Wireless Broadband (3G or 4G)
  - WiFi
  - Bluetooth
  - GPS Receiver

- **Estimated Future Expected Cost***
  - ~$500 Device
  - ~$50-$100 Monthly Service/Device

*Based on current services and estimates for additional services*
System of Systems

EAN: Extended Area Network
JAN: Jurisdictional Area Network
IAN: Incident Area Network
PAN: Personal Area Network

Source: SAFECOM SoR v1.1
Personal Area Networks (PAN)
System of Systems

EAN: Extended Area Network
JAN: Jurisdictional Area Network
IAN: Incident Area Network
PAN: Personal Area Network

Source: SAFECOM SoR v1.1
Incident Area Communications

Cell Tower

Direct Mode
Ad Hoc WiFi (802.11)

Dual Mode Device Capabilities

PTT Ad Hoc Network

Ad Hoc WiFi (802.11)

Mobile Ad Hoc Network (MANET)

WiFi
System of Systems

EAN: Extended Area Network
JAN: Jurisdictional Area Network
IAN: Incident Area Network
PAN: Personal Area Network

Source: SAFECOM SoR v1.1
Jurisdictional Area Networks

Static Nets
- City Police
- Fire-2
- EMS-1

Local Nets
- County Police
- Fire-2
- EMS-2

Visiting Nets
- City Police

ESZ 1000: City Police
  - Fire -1
  - EMS-1

ESZ 1006: City Police
  - Fire -1
  - EMS-2

ESZ 1005: County Police
  - Fire -1
  - EMS-2

ESZ 1002: City Police
  - Fire -2
  - EMS-1

ESZ 1003: City Police
  - Fire -2
  - EMS-2

ESZ 1004: County Police
  - Fire -2
  - EMS-2
System of Systems

EAN: Extended Area Network
JAN: Jurisdictional Area Network
IAN: Incident Area Network
PAN: Personal Area Network

Source: SAFECOM SoR v1.1
Extended Area Network
## Basic Services you should expect

<table>
<thead>
<tr>
<th>Service</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Push to Talk Voice</strong></td>
<td>Common Net Traffic used in current LMR Systems</td>
</tr>
<tr>
<td><strong>Status Data</strong></td>
<td>Periodic updates to centralized data base for biometrics, GPS Location Info, Equipment Data</td>
</tr>
<tr>
<td><strong>Instant Messaging</strong></td>
<td>Text Messages between responders</td>
</tr>
<tr>
<td><strong>Streaming Video/Data</strong></td>
<td>Still pictures or real streaming video. Real time biometric data feed.</td>
</tr>
<tr>
<td><strong>E-mail</strong></td>
<td>E-Mail w/ Attachments</td>
</tr>
<tr>
<td><strong>Web Browsing</strong></td>
<td>Access to Maps, Geolocation Data, Building Layouts, Medical and Criminal information</td>
</tr>
<tr>
<td><strong>Full Duplex Voice</strong></td>
<td>PSTN Phone Call</td>
</tr>
</tbody>
</table>
EMS Scenario

- Item Qty
  - Item 1: 5
  - Item 3: 2

Order

Activate A34
EMS Scenario
EMS Scenario
New Technology Concerns

- **Growing Pains**
  - Training, Initial Deployments

- **Costs vs. Benefits**
  - How will the costs be different?
  - What benefits will be provided me?

- **Service Provider?**
  - Full Package = Devices + Network + Host Based Services
Summary and Conclusions

- **Wireless Past and Present**
  - Size Matters

- **Wireless Future**
  - Major LTE deployments
  - Niche Markets for WiMax

- **First Responders and Wireless**
  - PANs, IANs, JANs, EANs